# APPENDIX C
# GEOLOGIC TIME SCALE; WELL COMPLETION REPORTS, LOCATIONS, AND REFERENCE ELEVATIONS; DETERMINING HYDRAULIC PROPERTIES; AND SPECIFIC YIELD VALUES

# GEOLOGIC TIME SCALE

| Relative Durations of Major Geologic Intervals |
|---|
| CENOZOIC |
| MESOZOIC |
| PALEOZOIC |
| PRECAMBRIAN |

| Era | Period | Epoch | Duration in Millions of Years (Approx.) | Millions of Years Ago (Approx.) |
|---|---|---|---|---|
| Cenozoic | Quaternary | Holocene | Approx. last 10,000 years | |
| | | Pleistocene | 2 | 2 |
| | Tertiary | Pliocene | 3 | 5 |
| | | Miocene | 18 | 23 |
| | | Oligocene | 15 | 38 |
| | | Eocene | 16 | 54 |
| | | Paleocene | 11 | 65 |
| Mesozoic | Cretaceous | | 71 | 136 |
| | Jurassic | | 54 | 190 |
| | Triassic | | 35 | 225 |
| Paleozoic | Permian | | 55 | 280 |
| | Pennsylvanian | | 45 | 325 |
| | Mississippian | | 20 | 345 |
| | Devonian | | 50 | 395 |
| | Silurian | | 35 | 430 |
| | Ordovician | | 70 | 500 |
| | Cambrian | | 70 | 570 |
| Precambrian | | | 4,030 | 4,600 |

(After: Eicher, 1976)

Formation of Earth's crust about 4,600 million years ago

## WELL COMPLETION REPORTS, LOCATIONS AND REFERENCE ELEVATIONS

Water well completion reports[1] and geophysical logs and oil well electric and geologic logs were used in this study to interpret hydrogeologic conditions and in the preparation of the cross-sections. No subsurface exploration or well testing was conducted for this study.

Well completion reports are to contain information such as name of well owner, driller's name and signature, dates drilled, well location description and map, a detailed geologic log of materials encountered during drilling of the well, drilling method, total depth of boring and of completed well, casing diameter, perforation details (such as type, size and depth), and gravel pack placement. The well completion report is also to contain information on planned use, depths to first water and standing or static water level, estimated yield of the completed well, type of yield test and length, and total drawdown.

Usefulness of well completion reports was frequently limited. Not all the required information on the reports was provided on many reports available for this study. The description of a well's location was often incomplete or inaccurate; thus the well's position could not be determined on a quadrangle sheet. The geologic logs on the reports varied in degree of detail and terminology used to describe the sediments. Wells with geophysical logs were more useful, but the number of wells with geophysical logs was limited. The information provided on the depth at which first water was encountered and static water level was often lacking or appeared to be inaccurate. The completeness and consistency of these reports varied between drilling companies and individual drillers. The deeper water wells were generally more useful for analyzing the hydrogeologic conditions.

Well locations and reference elevations are from field descriptions of the locations as plotted on USGS 7.5-minute quadrangles.[2] Reference elevations were approximated using either the 7.5-minute quadrangles or digital aerial surveys at 5- or 2-foot contour intervals, where the surveys were available. The sea water intrusion wells along the coast and a few other wells in the study area have surveyed reference elevations.

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[1]Before 1991, these reports were called "Water Well Drillers Report."

[2]In 2000, San Luis Obispo County located the wells in their monitoring program using GPS (Global Positioning System). Unrectifiable problems with the GPS data resulted in erroneous well locations and elevations and thus could not be used in this study.

## DETERMINING HYDRAULIC PROPERTIES

Aquifer hydraulic tests provide in situ determinations of hydraulic properties. Both transmissivity and storativity can be determined from tests based on water level drawdown and recovery measurements versus time using various nonequilibrium flow equations based on Theis (1935). Through the relationship of K = T/b,[3] hydraulic conductivity may also be calculated.

Aquifer hydraulic tests were not conducted for this study by the Department. However, several aquifer tests of wells had previously been conducted and analyzed by other agencies, consultants, or the Department. The hydraulic conductivity values determined from these tests are given in Table 20.

Pump efficiency tests and pumping-test data from drillers' reports not only provide information on the efficiency of the pump and the method of well construction, but also indirectly indicate the transmissivity and hydraulic conductivity of the aquifer material surrounding the well.

Data from these tests were used to compute specific capacity values. Using the specific capacity values, theoretical transmissivity values were empirically estimated employing the modified Thiem formula (T = c x 1,700).[4] From the transmissivity value and the saturated thickness penetrated by the well, an estimated value of hydraulic conductivity was derived using the formula given above. Values of hydraulic conductivity determined by this method are also given on Table 20.

It must be recognized that the calculations of transmissivity and hydraulic conductivity values from pump tests relate directly to the age, efficiency, condition, and design of the well and its perforations. This is because the key factor in the calculation is well drawdown(s). Wells that are old, have inefficient designs, contain precipitates or encrustation on perforations, or have limited open areas in their perforated intervals will have larger drawdowns, thus lower specific capacities, than wells with the opposite of such conditions.

To provide greater coverage of the groundwater basin and to serve as a comparative tool with the aquifer hydraulic tests and pump efficiency tests, values of hydraulic conductivity were estimated by correlating the lithology penetrated by selected wells as represented on drillers' reports with typical conductivity values of similar types of material from Figure 24. The various types of lithologic material described on the drillers' reports were assigned a range (low and high) of conductivity values. The values were weighted by the thickness of the material penetrated and then summed over the total saturated thickness to arrive at an estimated range of transmissivity values for the well. These values were divided by the entire saturated thickness penetrated by the well to arrive at an estimated range of average weighted hydraulic conductivity values for the

[3] K is hydraulic conductivity, T is transmissivity, and b is saturated thickness perforated by the well.

[4] T = c x 1,700, where T is transmissivity, c is tested specific capacity of the well, and 1,700 is a constant empirical factor. The factor 1,700 used in the modified Thiem formula in this study is based on studies of valley fill in California where it was found applicable for the type of well construction generally employed here (Thomasson et al., 1960, pp. 220-223).

well.

The thicknesses of the different deposits and formations penetrated by the wells were identified, thereby allowing the determination of estimated hydraulic conductivity values for the alluvium, the Paso Robles and Careaga Formations, and the Squire Member of the Pismo Formation  These values of hydraulic conductivity estimated by lithologic correlation are also presented on Table 20.  The wide range in values estimated by the correlation method can be explained by the ranges for geologic materials seen on Figure 24.

## SPECIFIC YIELD VALUES

Specific yield values representative for the drillers' terms compiled by the Department are given in Tables C1 and C2.

### TABLE C-1 - SPECIFIC YIELD VALUES USED IN COASTAL PLAIN OF LOS ANGELES COUNTY, CALIFORNIA*

**[After State Water Rights Board Revised Values of Specific Yield as used for San Fernando Valley Reference, 7-9-59, which is based on values used in Bulletin 45, Geology and Ground Water Storage Capacity of Valley Fill]**

**Note : Specific yield values above base of Bellflower aquiclude = 00**

**00 Percent—Bellflower Aquiclude**

**03 percent—Clay and shale**

| | | |
|---|---|---|
| Adobe | Granite clay | Shale |
| Boulders in clay | Hard clay | Shaley clay |
| Cemented clay | Hard pan | Shell rock |
| Clay | Hard sandy shale | Silty clay loam |
| Clayey loam | Hard shell | Soapstone |
| Decomposed shale | Muck | |

**05 percent—Clayey sand and silt**

| | | |
|---|---|---|
| Chalk rock | Rotten conglomerate | Sediment |
| Clay and gravel | Rotten granite | Shaley gravel |
| Clayey sand | Sand and clay | Silt |
| Clayey silt | Sand and silt | Silty clay |
| Conglomerate | Sand rock | Silty loam |
| Decomposed granite | Sandstone | Silty sand |
| Gravelly clay | Sandy clay | Soil |
| Loam | Sandy silt | |

**10 percent—Cemented or tight sand or gravel**

| | | |
|---|---|---|
| Caliche | Dead gravel | Heavy rocks |
| Cemented boulders | Dead sand | Soft sandstone |
| Cemented gravel | Dirty pack sand | Tight boulders |
| Cemented sand | Hard gravel | Tight coarse gravel |
| Cemented sand and gravel | Hard sand | |

**14 percent—Gravel and boulders**

| | | |
|---|---|---|
| Cobbles and gravel | Heaving gravel | Silty sand |
| Coarse gravel | Heavy gravel | Tight fine gravel |
| Boulders | Large gravel | Tight medium gravel |
| Broken rocks | Rocks | Muddy sand |
| Gravel and boulders | Sand and gravel, silty | |

**16 percent—Fine sand**

| | | |
|---|---|---|
| Fine sand | Quicksand | Sand, gravel and boulders |
| Heaving sand | Sand and boulders | Tight sand |

**21-23 percent—Sand and gravel**

| | | |
|---|---|---|
| Dry gravel | Gravelly sand | Sand |
| Loose gravel | Medium gravel | Water gravel |

**26 percent—Coarse sand and fine gravel**

| | | |
|---|---|---|
| Coarse sand | Fine gravel | Medium sand |

**Value of one added to given value where streaks of sand or gravel occur in clay or clayey material.**

* California Department of Water Resources, 1961, Planned utilization of the ground water basins of the coastal plain of Los Angeles County: California Dept. Water Resources Bull. 104, app. A, p. 121, Attachment 2, p. 2-3, 2-4.

## TABLE C-2 - SPECIFIC YIELD VALUES OF WATER-BEARING SEDIMENTS IN SAN LUIS OBISPO COUNTY, CALIFORNIA*

| Material | Specific yield (percent) | |
|---|---|---|
| | Alluvium | Paso Robles formation |
| Soil, including silty clay | 5 | 5 |
| Clay, including adobe and hardpan | 3 | 3 |
| Clay and sand, including sandy silt | 5 | 5 |
| Clay and gravel | 7 | 7 |
| Sand | 25 | 20 |
| Tight sand, including cemented sand | 18 | 15 |
| Gravel, including gravel and sand | 21 | 18 |
| Tight gravel, including cemented gravel | 14 | 13 |

*California Department of Water Resources, 1958, San Luis Obispo County Investigation: Bulletin No. 18, vol. II, Appendix B, p. B-27.

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